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ART. I.—*On Amputation at the Knee-joint, and at the Knee.* By JOHN H. BRINTON, M. D., one of the Surgeons to St. Joseph's Hospital.

THE propriety of disarticulation at the knee-joint is still a mooted point in the practice of American Surgery. By a majority of surgeons, the operation is, perhaps, regarded with suspicion. Many who in a given case of injury or disease would unhesitatingly amputate through the thigh, would in a similar case shrink from the performance of amputation at the knee-joint. The question naturally arises as to the cause of this reluctance. To a certain extent, it is probably owing to the existing dread of operative interference with so large a joint, and possibly, also, to a lack of information regarding the healing process of flaps formed upon articular surfaces. But more especially, we think, is the unpopularity of amputation at the knee-joint to be traced to a feeling of uncertainty as to the usefulness of the resulting stump, and to a strong misgiving regarding the immediate issue of the operation.

The surgeon who is called upon to select his point of amputation in the case of a mutilated or diseased leg, instinctively asks himself, whether amputation at the knee-joint affords his patient a better chance of recovery than amputation in the continuity of the thigh—and if it does, what will be the serviceableness of the resulting stump. Questions such as these cannot be answered by reference to purely theoretical opinions, but must be met by the production of authentic and carefully observed cases.

The object of the writer in the present paper is to submit the report of seven cases, in which he has performed amputation at the knee-joint, with known results. In several other instances occurring in military practice, he has performed the same disarticulation, but as the termination of these latter cases is unknown to him, he has not included them in the accompanying tables. In addition, he presents a series of cases, previously unreported, which have happened chiefly in the practice of surgeons in Philadelphia and its vicinity. A brief reference is also made to those well-authenticated instances of knee amputations, which have from time to time been reported in our own and in foreign journals. From the aggregate of cases thus obtained, an attempt has been made to deduce the mortality rate of the operation in question.

In a supplementary table will be found the reference to many European cases, most of which have been handed down from author to author. The difficulty of obtaining access to the original reports, their meagre and often inaccurate details, and the unsatisfactory nature of second-hand quotations, unfit these latter cases for the analytical purposes of this paper. Indeed it is very much to be doubted whether they possess any value other than that of a purely historical character.

Before attempting to examine into the merits of disarticulation of the knee, it may here be well to allude briefly to the more important papers which have from time to time appeared, bearing upon amputation at the knee-joint—and in this connection it must be observed that a distinction is to be made between amputation at the knee-joint and amputation at the knee. The former is a pure disarticulation, or at most a disarticulation accompanied by the removal of the articular cartilages of the femur, or of a small portion of the condyles. The latter, frequently spoken of in England as "Carden's amputation," is a more extensive operation. In fact, it is not an amputation at the knee-joint at all, but rather an amputation immediately above the joint; for in Mr. Carden's operation, although the anterior flap is cut from the integuments, and extends for some distance below the patella, yet the femur is sawn across at a point varying from one to two and a half inches above the articulation.

The removal of the lower extremity at the knee-joint is an operation of ancient date. It is vaguely alluded to by Hippocrates, Guy de Chauliac, and by Guillemeau (1612). It is stated that it was performed by Fabricius Hildanus (1632), but this is denied by Textor and Zeis. In later times it was advocated by Hoin, Brasdor, and Blandin, but was not generally received. Its introduction into modern surgery is undoubtedly due to the efforts of Velpeau, who published a memoir upon amputation at the knee in 1829. Of the fourteen authentic cases of amputation at the knee-joint collected by Velpeau, there were thirteen cures.[1] The results, however, of the same operation at the hands of this illustrious surgeon, as set forth in his treatise on operative surgery published in 1832, failed to realize his first encouraging anticipations. In his article upon amputation at the knee he then states, "I fear therefore that I may have exaggerated the safety of this operation when I attempted to revive it in 1830. It remains proved, however, that the objections which have been made against it have no solid foundation."

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[1] Archives générales de Médecine, t. xxiv. p. 44.

For many years after the publication of the above, little appears to have been done or published relative to knee-joint amputation. In November, 1852, Dr. Stephen Smith, in an admirable paper, in the *New York Journal of Medicine*, reported a case of disarticulation performed by Dr. Parker, of New York. He at the same time presented, in a collected form, all of the known and reported American cases, as well as the authentic foreign instances of the same operation.

In January, 1856, Dr. Markoe published in the same journal his well-known paper on amputation at the knee-joint, in which he reports six additional cases which had been mainly treated in the New York Hospital. The advantages of disarticulation at the knee, as compared with thigh amputations, are said by Dr. Markoe to be: 1. The useful character of the resulting stump; 2. The lessened shock of operation; 3. Lessened section of tissues; 4. The non-exposure of the muscular interspaces, and the diminished risk of suppurative inflammation of the thigh; 5. The comparatively few ligatures required; 6. The preservation of the attachments of the thigh muscles; 7. The absence of muscular retraction; 8. The escape from the necessity of sawing the femur, and the lessened risk of osteomyelitis and exfoliation.

In the number of the *New York Journal of Medicine* for November, 1856, Dr. Markoe published an article entitled "Syme's Amputation through the Knee, in Chronic Disease of the Joint," in which he advocated the performance of disarticulation at the knee in many cases of joint disease in which amputation of the thigh had previously been resorted to.

In May, 1845, Mr. Syme published in the *London and Edinburgh Monthly Journal of the Medical Sciences* an article upon "amputation of the knee." In the course of his remarks, Mr. Syme alludes to the heavy mortality which accompanies amputation of the thigh, from 50 to 70 per cent., and then states that having seen the circular incision give way to the flap, and having witnessed the results of the various operations in the hands of the most skilful surgeons, he is led to believe that there must be something wrong in dividing the thigh-bone through its shaft, instead of through its condyles.

The occasion for thigh amputation Mr. Syme states to be, in the order of frequency: 1. Diseases of the knee-joint; 2. Compound fractures of the leg and thigh; 3. Tumours growing from the bones of the leg and thigh. In knee-joint diseases, to use his expression, the "warrant for the amputation lies in the bone and not in the soft parts." In compound fractures of the leg, and in injury and diseases of the thigh, the greatest length of the thigh should be preserved, so that "taking merely the morbid condition into account, all the cases admitting of amputation at or below the middle of the thigh-bone would admit of the operation being performed through the condyles." Mr. Syme adds that when the operation is performed through the condyles, the medullary membrane is not disturbed, exfoliation of the bone will be avoided, and the patient will preserve a more useful stump. In support of his views he adduces two cases in which he had amputated at the knee.

The operation practised by Mr. Syme consisted in a division of the integuments on a line with the patella and the formation of a large flap from the calf of the leg. The condyles were sawn across and the patella was removed. Influenced by Mr. Syme's recommendation, his operation, in all its essential respects, was employed by Mr., now Sir William Fergusson, Dr. Williamson, Mr. Jones, of Jersey, Mr. Potter, of Newcastle, and others, who have reported their cases. At the hands especially of Mr. Fergusson, the operation was attended with success.

In 1864 Mr. Carden, of Worcester, published, in the *British Medical Journal* for April, a paper on amputation by the single flap, a process practised by him since 1846. In this article Mr. Carden reports thirty cases of amputation through the condyles of the femur, and one case which may be regarded as a proper disarticulation.

The success of Mr. Carden's operation appears, from his report, to have been very great; thus, of four cases of primary amputation after accident, one died, and three recovered; of three secondary amputations after accident, all recovered. He also reports twenty-four cases of amputations for pathological causes, such as diseases of the knee-joint, cancer, and gangrene. Of these, four died and twenty recovered. The large percentage of these recoveries would seem to be in a great degree owing to the character of the operation. This consisted in the reflection of a round or semi-oval flap of skin and fat from the front of the joint, the section of the soft tissues down to the bone, and the division of the femur strictly above the plane of the muscles, thus forming a flat-faced stump. When union was effected, the line of the cicatrix was drawn upwards and backwards, and escaped pressure in locomotion. The patella was removed in the operation.

By comparison of Mr. Carden's operation with Mr. Syme's, it will be observed that in both the thigh-bone was sawn through directly above the condyles, and in both the patella was removed. There was, however, this difference between the two: in Carden's operation the flap was formed of the integuments covering the front of the joint, and containing no muscular tissue, was not liable to slough, and united readily, forming a stump well suited to the application of an artificial limb. In Syme's operation, on the other hand, the flap formed from the muscles of the calf was not so well suited for a covering for the bone as in the former case. Indeed, the superiority of Mr. Carden's procedure over his own is admitted by Syme himself, in the *Edinburgh Medical Journal* for April, 1866, in which he states that the flap formed from the calf of the leg "proved very inconvenient, and so counterbalanced the benefit anticipated, that this operation soon fell into disuse." Mr. Syme considers that Carden's operation offers these advantages, viz: An ample anterior integumental flap, a short posterior flap, a transverse division of the vessels, a dependent opening to the wound, and an excellent position for the cicatrix. The resulting stump is in every respect a serviceable one, since the "skin over the stump instead of becoming thinner acquires additional thickness, so that the patients could rest upon it, just as they do after amputation at the ankle."

Amputation at the knee-joint proper.—This operation was performed first in Scotland, at the Glasgow Infirmary, in 1847. In England, it was first practised by Mr. Lane, at St. Mary's Hospital, London, in September, 1857. In reporting this case,[1] Mr. Lane dwells upon the advantages which this operation possesses over the ordinary process of amputating through the condyles of the femur. These advantages he believed were apparent in the decreased mortality (for the knee-joint 31 per cent.), and in the increased usefulness of the resulting stumps. Mr. Lane operated by a long anterior integumental flap, and by a short posterior flap, retaining the patella, and the whole of the condyles, with their incrusting cartilages. Mr. Lane has been followed in this method of operating by Sir William Fergusson, Mr. Coulson, of St. Mary's Hospital; Mr. Pollock, and Mr. T. Holmes, of St. George's, Mr. Holthouse, of Westminster, and Mr. Cooper Foster, of Guy's Hospital, and others.

In France the disarticulation at the knee has met with comparatively little favour, the later results of the operation apparently falling short of the sanguine anticipations which had been formed at the time of its revival by Velpeau. In 1854 M. Maisonneuve[2] performed this amputation upon a woman twenty-two years of age, and in his report of the case he states that "this operation has, during the last ten years, been performed only once or twice in Paris; but this proscription he does not consider merited. He regards this operation as less dangerous than amputation of the thigh, and it possesses this immense advantage that it leaves the patient in a far preferable condition for the application of an artificial limb."

The judgment of so distinguished a surgical authority as Malgaigne, regarding the merits of this disarticulation, is equally decided, and is thus pithily expressed.[3] "Encore une de ces opérations trop légèrement condamnées, et qui, lorsqu'on a le choix, mérite toute préférence sur l'amputation de la cuisse dans la continuité." "L'immense avantage qui suit cette désarticulation de l'amputation dans la continuité, c'est qu'elle conserve aux amputés le libre jeu de l'articulation coxo-fémorale."

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[1] Lancet, vol. ii., 1857, p. 324, and p. 474.

[2] Gaz. Méd. de Paris, Sept. 2, 1854.

[3] Manuel de Méd. Op., Paris, 1849, p. 316.

In Germany the exarticulation of the knee is but little practised, and chiefly by Textor, of Wurzburg, and in the surgical clinic at Tubingen. In Russia cases are reported by Heyfelder, of St. Petersburg; Vanzetti, of Charkow; and Mazanowski, of the Imperial service.[1] Prof. Heyfelder, who has operated in six cases, believes that amputation at the knee is better, and can be more readily borne by the patient, than thigh amputation.

Military practice.—In European military practice, the results of amputation at the knee-joint have, on the whole, been unsatisfactory. During the Crimean war the operation was performed in the British service six times primarily, with three deaths; and once secondarily, with a fatal result. But we are informed by Dr. Macleod that "to four of the cases operated on in camp, with the details of which I am acquainted, the operation was not applicable, as the femur was more or less injured, so as to call for the removal of part of it; hence the operation, although termed amputation through the knee, was in reality low amputation of the thigh, such as that now employed in acute swelling of the articulation." In weighing the arguments for and against the operation, Dr. Macleod is inclined to believe that the advantages of this operation more than counterbalance its disadvantages, and he adds that if the cases were selected for the operation, in which the femur was uninjured, and a sufficient flap could be obtained, and the operation performed early, then he firmly believed that he could coincide with Malgaigne in the opinion which we have already quoted.

The opinion of Mr. Longmore, as to the merits in military surgery of the amputation we are discussing, is decided. In a short criticism upon the operation published in the *British Medical Journal* for January 5, 1867, he expresses the hope that "in any future war, amputation of the knee-joint will be performed more frequently than it has hitherto been performed in our army, and with results at least as favourable as those recorded in the United States army reports."

In the Russian Service, during the Crimean War, but two cases of amputation at this joint are reported by Pirogoff. Both died, and a like fatal result obtained in the two cases reported by Demmé as having occurred during the Italian war.

In the French service, the results of disarticulation at the knee appear to have been particularly disastrous. M. Legouest, at page 735 of his *Traité de Chirurgie d'Armée*, indulges in a most sweeping denunciation of the operation, and dismisses its consideration in this summary manner:—

"La désarticulation du genou est une mauvaise opération, plus grave que l'amputation de la cuisse dans la continuité, et qui doit être rejetée de la pratique. Ou peut en juger par ces chiffres."

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[1] Canstatt, Jahresbericht., 1857, p. 218.

	Operations.	Deaths.	Rate per 100.
Paris hospitals—Malgaigne	3	3	100.0
" " Velpeau	6	4	66.0
Eastern campaign—English army	7	4	57.2
" " French army	78	71	91.0
Total	94	82	87.0

From the figures in this table, and more especially from those which represent the statistics of the French army in the East, it would seem that M. Legouest has reason to regard the disarticulation at the knee, as practised by French surgeons, with suspicion. But in his utter condemnation of the operation, we think he has gone too far; and we are unwilling to receive his decision as the final verdict of the operation. Indeed, from his own figures, the results of amputation at the knee-joint, disastrous as they are, still appear to be more fortunate than those of amputation in the continuity of the thigh. This is evident from an examination of his table comprising the results of thigh amputations in the French army during the same campaigns. Thus we find that of 1678 thigh amputations, 1544 died, a mortality rate of 92.2, against 91.0, the mortality rate of the French disarticulations at the knee. We therefore confess ourselves unable to understand M. Legouest's reasons for his unmeasured proscription of the latter operation.

By the military surgeons of the United States army, during the late rebellion, amputation at the knee-joint was frequently practised. In Circular No. 6, Surgeon-General's Office, Washington, November 1, 1865, Surgeon Otis states that up to October, 1864, one hundred and thirty-two cases of amputation at the knee-joint have been reported to the Bureau.

> "Of these, fifty-two recovered and sixty-four died. In six cases amputation of the thigh was subsequently performed, with three recoveries and three deaths. In ten cases the result is undetermined. These figures are encouraging, and if we look at the primary amputations alone, the result is still more gratifying. Of forty-nine cases of primary operations at the knee-joint, thirty-one recovered and sixteen died; while two underwent reamputation, of whom one recovered, and one, a tuberculous subject, died. This gives a percentage of mortality in primary amputations at the knee-joint of 34.9. The mortality in primary amputation at the lower third of the thigh is much larger than this; indeed it has been already indisputably proved by the Crimean statistics, and by M. Malgaigne, that the mortality in amputation augments in exact proportion as the incisions approach the trunk."

In a communication from Surgeon Otis, received since the preceding pages were penned, the following additional information has, with the permission of the Surgeon-General, been furnished to the writer. The whole number of cases of knee-joint amputations recorded in the Surgeon-General's office is two hundred and eleven. Of these ninety-six recovered, one hundred and six died, one is still under treatment, and in eight the result is undetermined. In twelve cases reamputation of the thigh was resorted to, in eight successfully, in three fatally, and one is still under treatment. Of one hundred and ninety-one cases in which the date of operation is recorded, one hundred and eleven were primary. The average mortality of the whole number of cases is thus 50.2, a percentage greater than that exhibited in Circular No. 6. This increase in the death-rate Dr. Otis states is due to the fact that the later operations have been collected from special reports, and refer chiefly to primary cases which died before reaching general hospitals.

If we compare these results of amputation at the knee-joint, embodied in Surgeon Otis's statistics, with those of thigh amputations performed during the same period, it is apparent that the advantages are greatly on the side of the former. Thus, Surgeon Otis reports fifteen hundred and ninety-seven terminated cases of amputation at the thigh, of which five hundred and sixty-eight recovered, and one thousand and twenty-nine died, a mortality of 64.43 per cent. Of these cases the precise date of amputation was ascertained in one thousand and sixty-one instances; four hundred and twenty-three were primary, and six hundred and thirty-eight were intermediate or secondary. For the former the mortality rate was 54.13; for the latter 74.76.

The conclusions thus arrived at from the examination of so large a number of cases occurring in military practice, tend greatly to strengthen the convictions which we had already formed from our personal observation. We believe that in a proper case, namely, where the gunshot injury is confined to the bones of the leg; or where a ball has opened the knee-joint, without injury to the femur; or where there is extensive laceration of the soft parts of the leg involving the main vessels, amputation at the knee-joint affords the best chance of safety to the patient; *provided*, a sufficient flap of integuments can be obtained. Indeed, even should the condyles of the femur be slightly injured, we are inclined to go further, and coincide in the opinion expressed by Dr. S. W. Gross, that in such a case the operation is not necessarily contraindicated. The character of the flap, however, must always be carefully considered, for where it is integumental and obtained from the anterior or lateral portions of the joint, the patient's chances of recovery are, we think, increased.

That the views above expressed as to the value of amputations at the knee-joint are not exaggerated is, we think, attested by the great number of operations (two hundred and eleven) which have been reported to the Medical Bureau. Dr. Hamilton, in his treatise on Military Surgery, when speaking of this amputation says: "We have ourselves operated many times in the field at this point, and without being able to state the results precisely, we have reason to believe that the operation has been more successful than amputations either immediately above or below the joint." He also adds, "that of the relative safety of this operation we have no doubt."

With this brief review of the operation of amputation at the knee-joint, the following cases are presented. The first seven were operated upon by the writer; the succeeding thirty-eight, operated upon by the various surgeons whose names are given, have not previously been reported, although in one or two instances short clinical notes appeared in the reports of hospital practice, before the termination of the case. The authority for the histories of these unreported American cases is manuscript information, obtained generally from the surgeon, occasionally from the patient; and personal examination by the writer.

CASE 1.—W. W., aged 11, admitted into St. Joseph's Hospital, Philadelphia, November 23d, 1859, with a compound comminuted fracture of both bones of the right leg, just below the knee-joint, the result of a railroad accident. He had lost a good deal of blood, and the leg was irretrievably ruined; it was therefore decided to remove it at once. As his condition was not good, it was exceedingly desirable to perform such an operation as would be attended with the least amount of shock. At eight o'clock in the evening, about one hour and a half after the accident, I performed amputation at the knee-joint by the double flap method; the anterior flap being purely integumental, while the posterior contained the heads of the gastrocnemius muscle. The condyles of the femur were left with their articular cartilages, and the patella was not disturbed. Ligatures were applied upon the anterior and posterior tibial, and the two sural arteries, and coaptation of the flaps effected. November 24th. Twenty-eight hours after the operation, at midnight, secondary hemorrhage set in, which, although temporarily arrested by styptics, recurred again at 7 A. M., November 25th, to such an extent as to necessitate the opening of the wound. This I accordingly did, breaking up the commencing adhesions, when I found that the bleeding proceeded from the enlarged and divided vessels of the synovial membrane, particularly from those distributed in the intercondyloid region; seven or eight ligatures were applied, and the lips of the wound were again brought together. The child, who was much exhausted by loss of blood, gradually reacted under stimulus and good diet. December 5th. The flaps having failed to unite a second time, the condyles projected at either angle of the wound, and granulations formed freely upon the bone up to the line of the articular cartilages. These latter now softened and became thinner, so as to render distinctly visible the vessels upon the surface of the bone beneath. Granulations formed rapidly upon the crucial ligaments. December 10th. The last ligature separated. December 13th. During the preceding week the cartilage covering the outer condyle disintegrated molecularly, and its place was supplied by healthy granulations from the bone; the cartilage covering the inner condyle gradually loosened from its attachments, and was removed by the forceps in an entire layer. The surface of the bone beneath was covered with florid, healthy granulations, which by the 25th of December had attained to the same height as those growing from the other portions of the bone, so that at this time, the entire granulating surface of the stump presented a uniform, smooth level. Cicatrization now rapidly ensued, and on the 23d of February the child left the hospital with a well healed, solid stump. The convalescence of this patient had been somewhat retarded by the formation of one or two abscesses upon the thigh, which were opened.

I examined the patient in the early part of 1866, and subsequently in 1867. He is now fully grown, and in good health. He walks with a crutch from preference, his circumstances having hitherto prevented the purchase of an artificial limb. The stump is firm, round, not painful upon pressure, and possesses great power of rotation, abduction, and adduction. The patella is drawn upwards about two inches towards the outer surface of the limb.

CASE 2.—W. McG., aged 10, admitted into St. Joseph's Hospital October 17, 1865, with a compound comminuted fracture of the tibia and fibula immediately below the knee. He had been run over by a street car in the afternoon. The hemorrhage had been considerable, and the shock of the injury was severe. On the same evening I removed the limb at the knee-joint, making a long anterior and a short posterior integumental flap. The heads of the gastrocnemius were shaved off, and the popliteal artery was cut squarely through. Ligatures were applied upon this vessel, two articular arteries, and upon the popliteal vein. The condyles and patella were left, and the articular cartilages were not disturbed. Nearly perfect union by first intention ensued; a very small slough formed over the external condyle, a portion of the cartilage of which came away in one layer, when granulation from the subjacent bone rapidly took place. The last ligature separated on November 4th, and the boy was discharged from the hospital cured on December 18th, with a perfectly rounded stump, capable of great motion and powerful rotation.

This child was subsequently admitted into the hospital with a simple fracture of the same thigh, caused by a fall from a wagon. The stump in the interim was sound and painless. The fracture of the femur quickly united, and he left the hospital well.

CASE 3.—Mrs. Ellen P., aged 22, of New Jersey, admitted as a private patient into St. Joseph's Hospital July 19th, 1866, with a large pulsating tumour of the right foot. The pulsation was most marked on the outside, just below the external malleolus, and could also be felt upon the inner side near the point of the heel. The internal saphena vein was greatly enlarged, and a purring sound could be distinctly heard over it, almost as high up as the knee. No cause could be assigned for this affection; the patient stated that it had existed for about two years, and that hemorrhage from an ulcer on the outside of the tumour frequently occurred to an alarming and weakening extent.

Finding that simultaneous pressure upon the anterior and posterior tibial arteries controlled the pulsation in the tumour, I tied, on the 26th of July, these vessels in their middle third. The operation was troublesome, from the fact that even the smallest veins, when divided, bled with an arterial jet. I at the same time tied the internal saphena vein, and the venæ comites of the arteries, all of which pulsated. After these ligations, the tumour decreased in size and the pulsation in it ceased.

On the 28th of July the pulsation in the tumour returned, and hemorrhage occurred from the ulcerated point on its surface. This was for the time controlled by pressure and styptics. The styptic which I employed was one which I have used largely in military practice with marked success, and which was originally suggested to me by Doctor Pancoast. It consisted of castile soap, one drachm; carbonate of potash, two drachms; and alcohol, four ounces, applied upon a pledget of lint. On July 31 I removed the limb at the knee-joint. I selected this point for amputation on account of the diseased condition of the vessels which my previous operations, as well as auscultation at the time, informed me extended above the middle of the leg. The operation was precisely similar to the one described in the preceding case, by the formation of a long anterior and short posterior integumental flap; the condyles and their cartilages, and the patella were left untouched. The popliteal artery was cut short, and the end of the ischiatic nerve excised. Seventeen ligatures were applied, all but three or four upon veins, which were greatly enlarged. The anæsthetic used was chloric ether. But little blood was lost, and the patient rallied promptly and perfectly from the shock of operation. On the following morning I found her, to my great surprise, sitting up in bed and knitting.

Union throughout four-fifths of the wound took place by first intention. The suppuration from the wound was moderate. The last ligature, that upon the popliteal artery, came away on the 23d of August, and early in September the patient returned to her home well, and with a perfect stump, possessing the usual great mobility peculiar to that amputation. In October, 1867, Mrs. P. was fitted with an artificial limb, upon which she walked with facility.

CASE 4.—On the 2d of April, 1867, I was called to see Mr. B., a gentleman aged 53, whose leg had been caught in the belting of machinery, by which it had been dragged through the opening in the floor for the belt, producing a compound dislocation of the ankle-joint, with fracture of the tibia and fibula. The dislocation was reduced, and every effort was made to save the limb. These efforts, however, proved unsuccessful, and accordingly it was determined, in consultation with Drs. Gross, S. W. Mitchell, and J. C. Norris, to remove the limb. The condition of the parts forbidding amputation in continuity of the leg, on the 7th of April, I amputated at the knee, by the process employed in the two foregoing cases. The patient's morale and general condition were fair, with the exception of an occasional irregular action of the heart. Ether was very cautiously administered. He bore the operation well; lost very little blood, and reacted promptly; about forty minutes, however, after the completion of the operation, and after he had been placed back in his bed the heart's action became exceedingly irregular, and he appeared to be suffering from severe shock, from which he was roused with difficulty by means of alcoholic and diffusible stimulants. His intellect was clear.

On the 9th and 10th of April his condition was only tolerable, and he was troubled much by irregular cardiac action. On the evening of the 11th he went to sleep with a clear mind, but awoke about 9 o'clock violently delirious, and with uncontrollable jactitation, screaming continuously, and tossing and tearing the coverings from his bed. On the 12th he became more quiet, although still delirious, and recognizing no one. He continued in this condition for about thirty hours, becoming gradually more and more exhausted, and died early on the morning of the 13th of April. No post-mortem examination of the body was permitted. The death, in all probability, resulted from cerebral effusion or extravasation. The appearance of the stump, when opened after death, was in no respects abnormal.

CASE 5. Mr. T. E. B., on the 5th of June, 1867, fell under the wheel of a street car, receiving a compound fracture of both bones of the left leg, at the junction of the lower with the middle third. He was admitted into St. Joseph's Hospital on the same day, and an attempt was made by the surgeon on duty to save the limb. The leg was placed in a fracture-box, and the usual bran dressing was employed. In the course of a month bony union of the fracture to a certain degree took place, but the external wound did not entirely heal. Abscesses also formed in the leg, above the seat of fracture, and burrowed toward the knee, and the integuments assumed an unhealthy appearance. On the 7th and 8th of July, three severe hemorrhages occurred from the open wound; these were restrained by pressure. During the summer the patient's condition improved, the leg became somewhat stiffer, and although the external opening did not entirely heal, the man was regarded as convalescent.

On the 9th of November a very severe secondary hemorrhage took place from the external wound; this was arrested by pressure over the femoral artery. On the night of the same day, during the patient's sleep, the hemorrhage recurred to a fearful extent, saturating the bed. It was controlled by the tourniquet.

On the morning of November 10th, in consultation with the surgical staff of the hospital, I removed the limb at the knee-joint. I was led to choose that point of operation by the evidently impaired vitality of the integuments and the doubtful condition of the bone, but more especially by my desire to avoid subjecting the patient, in his then weakened and ensanguine state, to any shock which might possibly be avoided. The operative procedure employed was that already described in the preceding cases. Ligatures were applied upon the popliteal artery and vein, and upon one articular artery. The end of the popliteal nerve was excised.

This patient did well, and the ligature on the popliteal artery separated on the tenth day after the amputation. A slight slough formed upon the lower flap, which was followed by granulation. A small portion of articular cartilage remaining as a foreign body, kept up some little irritation, which retarded the cure. The stump is now becoming firm, is not painful upon pressure, and promises to be satisfactory.

CASE 6. At the battle of Fredericksburg, in December, 1862, I amputated at the knee-joint, for gunshot fracture, the leg of a soldier about thirty years of age. The process employed was the same as that already described. Although I did not see this man after the operation, I subsequently learned that he did well, and recovered with a good stump.

CASE 7.—During General Grant's Wilderness campaign, I amputated at a hospital in Fredericksburg, the leg of a young soldier at the knee-joint. The injury was a gunshot wound of the upper portion of the tibia, involving the articulation. The process was that already described. This man did well for three days. At the expiration of this time, orders were received to remove all patients from the temporary hospitals, and to vacate Fredericksburg. I was subsequently informed that as this soldier was being lifted into the ambulance for transportation to the boat, a sudden and uncontrollable hemorrhage occurred, which proved almost immediately fatal. Owing to the pressing exigencies of the occasion, opportunity was not afforded for an examination of the stump after death.

CASE 8.—Operations by Dr. D. Hayes Agnew. Bridget B., aged 30, of strumous diathesis, an inmate of the Philadelphia Hospital, had suffered from an affection of the right leg for a period of twenty-five years. The ankle was anchylosed, and the tibia was diseased for nearly its whole extent. There was great ulceration of the leg. In December, 1859, Dr.

Agnew amputated the limb at the knee-joint, making a long anterior integumentary flap, including the patella, and a short posterior skin flap. The semilunar cartilages were removed.

Union by first intention to a great extent took place, and the patient recovered at the expiration of five weeks, with an excellent stump, possessing great motion. She has since worn an artificial limb without the slightest inconvenience.

CASE 9.—P. W., a German, aged 50, a patient, an inmate of the Philadelphia Hospital, had suffered for six years from a chronic ulcer of nearly the entire circumference of the lower half of the leg, with extensive necrosis of the tibia. In October, 1864, Dr. Agnew amputated the limb at the knee-joint, by the same operation as in the last case. The patient recovered promptly.

CASE 10.—A German, of middle age, had been run over by a street car, which terribly mutilated one leg, and produced also severe internal injuries. Reaction was slow and never very well established. Amputation at the knee-joint was performed by Dr. Agnew at the Philadelphia Hospital several hours after the occurrence of the accident in the same manner as in the preceding case. The patient died within twenty-four hours; more from his bodily injuries than as a result of the operation.

CASE 11.—An Irishman, aged 27, of great physical development, was brought into the Pennsylvania Hospital, in 1866, with a compound comminuted fracture of the bones of the leg, as high as the tubercle of the tibia. The injury was caused by the wheel of a street railroad car. The leg was amputated primarily, by Dr. D. H. Agnew, at the knee-joint in the same manner as in the preceding cases. The recovery in this instance was tedious, not caused by any misbehaviour on the part of the stump, but from abscesses which formed in the thigh; the result, in Dr. Agnew's opinion, of contusions received at the time of the accident. This patient was discharged from the hospital cured in about twelve weeks with a serviceable stump upon which he has since worn an artificial limb.

CASE 12.—Operation by Dr. Edward Peace. E. McH., aged 15, was admitted into the Pennsylvania Hospital for a deformed and ulcerated leg, the result of a railroad injury received six years previously. On Sept. 17th, 1844, Dr. Peace amputated the leg at the knee-joint by antero-posterior flaps. The patella and condyles were not disturbed. The wound was long in healing, but the boy recovered and was discharged from hospital, March 1st, 1845. [MSS. information received from Dr. George W. Norris.]

CASE 13.—Operations by Dr. A. Hewson. A young man, aged 26, was admitted into the Pennsylvania Hospital, in 1862, with a compound comminuted fracture of the leg produced by a railroad car. Primary amputation at the knee-joint was performed. The procedure employed was that by antero-posterior flaps. The articular surfaces of the condyles were sawn off, as also was that of the patella. The latter bone was then brought down upon the sawn face of the femur, as in Gritti's operation. This patient recovered with a good stump.

CASE 14.—A man, aged 37, was taken to the Pennsylvania Hospital, in 1862, with a leg crushed from a railroad accident. The limb was removed by Dr. A. Hewson at the knee-joint by a primary amputation performed in the same manner as in the preceding case. The man recovered with a satisfactory stump.

CASE 15.—L. N., aged 23, was admitted into the Pennsylvania Hospital, in 1863, for a railroad injury of the bones of the leg. Primary amputation of the limb at the knee-joint was performed by Dr. A. Hewson, the same procedure as that already described. Two acupressure needles were used to arrest the hemorrhage. This patient died from pyæmia about three weeks after the amputation.

CASE 16.—Miss G., aged 22, suffered from a large enchondromatous tumour of the leg. In April, 1863, the limb was amputated by Dr. A. Hewson, at the knee-joint, by the process described in the preceding cases. The patient recovered rapidly, with an admirable stump. She has worn an artificial limb ever since.

CASE 17.—E. S., received a compound comminuted fracture of the foot from a railroad accident on the 19th of March, 1866. The laceration of the skin extended as far up as the knee. Primary amputation was performed by Dr. A. Hewson at the knee-joint, as already described. One acupressure pin was employed. The patient did well, although a troublesome ulcer remained on the stump which delayed his discharge from the house until the 5th of November, two hundred and thirty-one days after his admission.

CASE 18.—Operations by Dr. F. F. Maury. S. C., aged 14, was admitted into the Philadelphia Hospital in the spring of 1867. She had a spina-bifida from birth. The tumour, at the date of admission, was the size of a large cocoanut. She had also lateral curvature of the spine. Until she reached the age of twelve years her general health was good; she suffered no inconvenience from the spinal tumour, except that she could not sleep on her back. Talipes valgus of the left foot developed itself during her twelfth year. More than a year before her admission she trod upon a piece of glass with her right foot. Inflammation ensued, followed by ulceration and sloughing, which extended to the tarsal bones, opening the joint, involving the bones as well as the soft parts, and subsequently almost separating the foot from the leg.

On the 11th of September the leg was amputated at the knee-joint, by antero-posterior integumental flaps. The patella was retained, and also the condyles of the femur with their cartilages. Very little blood was lost during the operation. The child did well for four days, but on the 15th, symptoms of trismus became apparent, followed on the 16th by general spasms, and on the 17th by complete opisthotonos. She died at 3.30 A.M. on the 18th. The treatment in this case consisted in the hypodermic use of sulphate of morphia, and of the fluid extract of the calabar bean.

CASE 19.—In March, 1864, a coloured man, aged about 35, was admitted into the Philadelphia Hospital with gangrene of the leg, the result of exposure to cold. Amputation at the knee-joint by a long-anterior, and short-posterior integumental flap, was performed by Dr. F. F. Maury. The patella was left, and the articular surfaces of the condyles of the femur were shaved off. The vessels were found to be filled with fibrinous clots; there was little or no hemorrhage, and no ligatures were applied, not even to the popliteal artery. The angles of the wound subsequently sloughed, so as to expose the condyles of the femur. These were sawn off, and granulation of the whole surface resulted. This man made a satisfactory, though somewhat tardy cure. He was discharged from the hospital well, with a good stump, and afterwards walked with a peg leg.

CASE 20.—Operation by Drs. Lilly and Coleman, of New Jersey. H. K., between 25 and 30 years of age, an engineer on the Belvidere and Delaware Railroad, had his leg crushed to the knee, in a railroad collision on the 6th of July, 1858. The following account of this case has been furnished the writer by Dr. Lilly:—

"Upon examination we found that the tibia and fibula were so crushed and comminuted that an amputation below the knee was impossible. The option was presented of cutting through the knee-joint, or of amputation through the femur. Upon consultation we decided on the former, there being sufficient integument uninjured on the posterior surface of the leg for a good flap. The tendon of the patella was divided about an inch below that bone; the joint was severed by a few strokes of the catlin, and the flap was formed by a single cut with that instrument. The synovial membranes, and the cartilages covering the condyles of the femur, were freely scarified with a scalpel, and to that we attributed the absence of synovial fluid during the healing process, which was accomplished in about six weeks without any untoward symptom.

"The stump, which was fitted with an artificial limb by Mr. Palmer, of Philadelphia, is a most serviceable one—much better, I think, than could have been obtained from an amputation of the thigh. K——, since the accident, has led an active life, walking without the use of a cane or crutch, and is now, and has been for some years, running an engine in the employ of the railroad company."

CASE 21.—Operations by Dr. T. G. Morton. A. H., aged twelve years, of strumous parentage, was admitted into the Pennsylvania Hospital June 3, 1864, for long-standing scrofulous disease involving the ankle-joint, and with caries of the tibia in its entire extent. Amputation at the knee-joint was performed June 11, by a long anterior and short posterior flap. The condyles of the femur were ulcerated, and their extremities were therefore removed; six ligatures were applied, and the wound was closed with lead sutures. The patient's health improved rapidly, and the stump was well in twenty-four days. She was discharged cured July 11, 1864, with a good stump.

CASE 22.—W. N., aged 30, Co. N, Pennsylvania Volunteers, was admitted into Satterlee Hospital June 10, 1863. He had received a compound comminuted fracture of the right leg, from a conoidal ball at White Oak Swamps, Va., June 29, 1862. Amputation was performed the same day on the field, but the flaps sloughed, and afterwards excessive hyperostosis of the extremities of the bones occurred with ulceration. (See p. 47, Circ. No. 6, and Catalogue A. M. M., Spec. 2778, p. 53 S. G. O.) Reamputation at the knee-joint was performed by Dr. Morton by long anterior and short posterior flaps, August 27, 1863. The patella and condyles were not disturbed. This patient made a good recovery, with a useful stump. Discharged March 3, 1864. December 24 the stump was good, and had caused no trouble since the operation. The extremities of the condyles were somewhat absorbed, and the end of the stump was flattened. The integument was quite movable, and the patella was drawn up about an inch and a half, and occupied a central position. He has worn an artificial limb ever since.

CASE 23.—A soldier, aged 46, was treated in the Satterlee Military Hospital for extensive necrosis of the bones of the right leg, and loss of the integuments, the result of a shell wound. In this case amputation was performed by Dr. T. G. Morton at the knee-joint by antero-posterior integumental flaps, retaining the patella and condyles of the femur. The cure, although protracted, was satisfactory.

CASE 24.—J. M., a labourer, was brought to the Pennsylvania Hospital June 11, 1864, having been run over on the Pennsylvania Railroad. Both legs were crushed below the knee. The man was very much intoxicated, and his condition did not warrant immediate operation. On the morning of June 12 the right leg was amputated by Dr. T. G. Morton at the knee-joint by long anterior and short posterior integumental flaps, leaving the patella and condyles intact. The left leg was at the same time amputated four inches below the knee-joint. But very little blood was lost in these operations; the patient reacted, but died at ten o'clock on the same night.

CASE 25.—J. M., aged 31, on the 15th of December, 1864, was admitted into the Pennsylvania Hospital with a compound comminuted fracture of the right leg, from a railroad accident. Amputation of the leg in continuity was performed by Dr. T. G. Morton, ten hours after the injury. Extensive sloughing, with burrowing abscesses and necrosis of the bones of the stump ensued. Four weeks afterwards the head of the tibia became necrosed. In April, 1865, re-amputation of the limb at the knee-joint was performed by antero-posterior integumental flaps. The patella was saved, but the extremities of the condyles of the femur were sawn off. This patient did well, and was discharged cured on the 20th of June. He has since been employed as an attendant at the Pennsylvania Hospital for the Insane, and for the last two years has not lost a moment from work on account of the stump, which is well rounded, with loose integuments. He is able to rest a great portion of his weight upon the stump.

CASE 26.—J. R., a negro, aged 37, received on the railroad, Dec. 12th, 1865, a compound comminuted fracture of the right tibia and fibula, which extended up into the joint. Amputation at the knee-joint was performed, by Dr. T. G. Morton, according to his usual antero-posterior flap method. The patella was saved, and the extremities of the condyles sawn off. Three vessels required ligation. The case did well until December 12th, when the patient had a violent chill, which was followed by great prostration. The chills recurred at intervals, and death took place on December 21st, 1865.

Autopsy.—Numerous secondary deposits were found in the lungs—pleuritis also existed. No deposits were found in the abdominal viscera. The lymphatic glands of the right thigh were enlarged and suppurating; the right femoral vein contained an ante-mortem, and partially decomposed coagulum.

CASE 27.—J. K., aged 56, a woman of feeble health, received a compound fracture of both bones of the left leg, at the junction of its middle and lower thirds by a fall from a height of two feet. Amputation was advised, but was not consented to by the patient, on the day of the accident, October 18th, 1867. Extensive necrosis, and deeply dissecting abscesses then formed in the leg. Amputation at the knee-joint was performed by Dr. T. G. Morton, December 1st, 1867, by lateral integumental flaps. The patella and condyles were left undisturbed. Four ligatures were applied. About the 5th day after the operation an abscess formed upon the inside of the thigh, which was opened. On the 11th day the last ligature separated. A portion of the flap covering the external condyle sloughed, but the granulations from the bone sprang up rapidly, and by the expiration of the 30th day the surface of the stump was healed. The patient is perfectly recovered, and will have a useful stump.

CASE 28.—Operation by Dr. Wm. Hunt. M. L., aged 20, was admitted into the Pennsylvania Hospital September 12th, 1864. He had some months previously met with a railroad accident, for which his leg had been amputated in continuity. He now entered the hospital on account of an ulcer which existed upon his stump. Dr. Morton endeavoured by a species of plastic operation to remedy this trouble, but retraction of the tissues occurred, and Dr. Hunt was subsequently obliged to reamputate the limb. The operation was performed at the knee-joint, the articular surfaces of the condyles and patella were sawn off, and the patella was then turned down upon the sawn end of the femur, to which it formed a firm union. The patient was discharged from the hospital on the 17th of February, 1865, 158 days after the last operation. He wore an artificial limb with ease, and has since returned to Ireland.

CASE 29.—Operations by Dr. Kenderdine. B. W., aged 37, female, was received in the Pennsylvania Hospital May 19th, 1864, for scrofulous caries of the left ankle and foot. Eight months previously her right leg had been amputated at the knee-joint, by Dr. Kenderdine. The patella had been saved, and the extremities of the condyles had been taken away. The stump was an excellent one in every respect. Its extremity was very flat, and the integuments were movable over it.

CASE 30.—In 1862 Dr. K. at the Philadelphia Hospital, amputated at the knee-joint the leg of a middle-aged man, for necrosis of the tibia and fibula. The patella, and the condyles of the femur were taken away; the flaps were integumental, and were formed from the anterior and posterior surfaces of the limb. At the time of operation, this man was in a very poor condition. He died at the expiration of twelve days, from pyæmia.

CASE 31.—Operation by Dr. Edward Shippen (late surgeon U. S. Vols.). On February 18th, 1865, Corp. E. P. R., Co. G., 107th Ills. Vols., was wounded before Fort Anderson, on the Cape Fear River, a few days before the capture of Wilmington, N. C. Both bones of his left leg were shattered by a shell, and at the same time the muscles of the calf were horribly mutilated. Four or five hours after the reception of the wound, surgeon Shippen amputated the leg at the knee-joint, by Bauden's operation, leaving the patella and condyles undisturbed. The patient was under the influence of chloroform. After the operation he did well for some days, and was sent North on the hospital steamship Spaulding, on the 28th of February. Dr. S. has since been informed that this soldier died of pyæmia at the Jarvis Hospital, Baltimore, on the 22d of April, more than two months after the operation was performed.

CASE 32.—Operation by Dr. Erskine Mason, of New York. In December, 1867, the writer examined the stump of J. M., whose leg had been amputated at the knee-joint. This man stated that in February, 1864 he had been wounded at the battle of Olustee, Florida, by a musket-ball, which lodged in the substance of the patella, and was removed on the following day. He remained a prisoner at Tullahoma for three months, and at Andersonville for six months, and was exchanged at Savannah in November of the same year. He was afterwards treated at the Chestnut Hill Hospital, Philadelphia, and was discharged from service in the early part of 1865. On the 28th of May, 1865, his leg was amputated at the Blackwell's Island Hospital. Dr. Mason, the operator, in a letter to the writer, states that at that time the joint was painful, enlarged, and partially anchylosed. The leg was atrophied, its temperature low, and there was great venous congestion. The operation was performed by antero-posterior flaps, the heads of the gastrocnemius being included in the posterior flap. The condyles of the femur were found to be eroded, and about one inch of their extremities was sawn off. On the evening of the day of operation there was some secondary hemorrhage, which was checked by the application of ice. The flaps, however, healed almost by first intention.

The patient was confined to his bed forty-eight days, and was discharged from the hospital cured, at the expiration of about sixty days.

When examined by the writer, the patella was found to be firmly adherent to the anterior surface of the femur, and the condyles were flattened; the stump was a model one in every respect. There was no pain or tenderness; the patient was able to bear his whole weight on the end of the stump, to move about freely and to jump with his artificial limb, which was a home-made peg. This he had worn since July 17, 1865.

CASE 33.—C. S. P., a soldier, 12th New York Volunteers, was wounded in the leg June 3d, 1864, at the battle of Cold Harbor, Va. He lay on the battle-field all day, and on the following morning his leg was amputated at the knee-joint. The flaps were integumental, and were obtained from the front and back of the limb. The patella was left; the articular surfaces of the condyles were removed. This soldier recovered rapidly, and at the expiration of nine months from the time of operation could walk freely with an artificial limb. He can now bear his full weight upon the end of his stump. The movements of rotation of the thigh are very perfect.

CASE 34.—Amputation at the knee-joint was performed by a distinguished surgeon upon a young adult patient. The condyles and patella were not removed. The patient recovered; an artificial limb of the most approved pattern was fitted to the stump, and the patient's daily avocations were resumed. These were arduous in nature, and demanded constant locomotion; as a result, excoriation of one or two points upon the surface of the stump took place; the patient became dissatisfied with the stump, and a reamputation in the continuity of the thigh was subsequently performed by another practitioner.

The mechanician who adjusted the artificial limb used before reamputation, stated to the writer that when he examined the stump, the excoriation was small, superficial and apparently of little importance. It had been caused by excessive walking. The adjustment of this limb, he stated, could easily have been arranged so as to have taken away all pressure from the end of the stump. The interval between the two operations was several years.

CASE 35.—Operation by Surgeon E. Bentley, U. S. Volunteers. E. L. P., æt. 21, received a shell wound of the leg at the battle of Cedar Mountain, Va., August 9, 1862. Primary amputation at the knee-joint was performed by the surgeon above named. The articular surfaces of the condyles were sawn off, and the patella was left; the stump healed rapidly and the patient recovered without accident in four months. He has since been in four battles, and on one occasion was captured and was obliged to walk fifty-four miles between sunrise and 9 o'clock P. M. The stump is painless, and the patient has informed the writer that he can walk, dance, mount his horse and ride with perfect facility. He attributes much of the usefulness of his limb to the presence of the patella. The writer has had frequent opportunities of examining this stump, and of seeing Captain P. walk and ride; the stump is in every respect excellent, and one of the very best he has ever seen.

CASE 36.—Operation by Doctor Pancoast. On the 27th of June, 1863, J. P. H., a boy aged 8, was admitted in the Pennsylvania Hospital with a crushed fracture of the leg, the result of a railroad accident. Immediate amputation was performed at the knee-joint by Dr. P., who sawed off the condyles, leaving the patella, and making long anterior and short posterior skin flaps. The child did well until the fourteenth day after the operation, when he had a marked chill; the flaps sloughed, and the patella which had been left upon the sawn end of the femur retracted, and the end of the femur was left uncovered; he grew worse and died of pyæmia thirty-two days after admission. At the post-mortem examination metastatic abscesses were found in the lungs, liver, and spleen.

CASE 37.—Amputation at knee-joint by Dr. Stephen Smith. Margaret B., aged 65, Irish, admitted to Bellevue Hospital November 21, 1866. She stated that a short time since, while crossing a street, she was knocked down and run over by a loaded truck. On examination the tibia and fibula were found to be fractured about three inches above the ankle-joint; the tibia was much comminuted, and communicated externally by a small opening. The soft parts were greatly contused. Dr. Smith proceeded to amputate the leg at the junction of the upper and middle thirds, but finding the tissues in very bad condition, he extended his incisions, removing the limb at the knee-joint by internal flaps. The patella and condyles were left. The patient did well, a small portion of the flap sloughed over the posterior portion of the external condyle, but the surface soon granulated. By the third of January, 1867, the wound was healed with the exception of one small ulcer. By the 1st of April the wound was completely healed. Dr. Smith now writes (January, 1868), that the cicatrix lies behind the stump, between the condyles, and does not rest upon any portion of the face of the stump, or over the condyles. The stump is an excellent one, and bears pressure well.

CASE 38.—In 1860 Dr. S. D. Gross amputated, at the knee-joint, the leg of a woman aged 45, for compound fracture of the bones of the leg. The operation was immediate. The flaps were anterior and posterior, and were formed from the integuments. The patient recovered with an excellent stump.

CASE 39.—The same surgeon, in the year 1862, for gangrene following a complicated fracture of the leg, successfully removed at the knee-joint the limb of a woman aged 55. The flaps were formed in the same manner as in the preceding case. The articular surfaces of the condyles were shaved off and the patella was left. The resulting stump was serviceable and satisfactory.

CASE 40.—In 1863, Dr. John K. Kane, of Wilmington, Delaware, at the Chester Hospital, amputated at the knee-joint the leg of S. L., æt. 18, a soldier who had received a gunshot fracture of the tibia and fibula several months previously. The flaps, which were integumentary, were obtained from the front and back of the limb; the patella and condyles were left. The patient died six days subsequent to the operation from pyæmia.

CASE 41.—H. C. P., æt. 30, Co. B, 12th N. Y. Vols., on the 27th of June, 1862, received a gunshot fracture of the right tibia. The ball was not extracted, but remained resting against the posterior surface of the tibia. Extensive necrosis of the tibia, with sloughing of the soft tissues, resulted. The patient was sent to Chester Hospital, and on March 14, 1863, Dr. Draper, of Wilmington, Delaware, disarticulated the leg at the knee-joint, by the long anterior flap method. The patella and condyles were left undisturbed. The cure was effected rapidly, and the resulting stump was good.

CASE 42.—W. H., æt. 28, Co. B, 14th Tenn. Inf., C. S. A. Admitted into Chester Hospital July 17, 1863. He had been wounded on July 3, by a ball which fractured the tibia just below the tuberosity. Extensive sloughing had occurred, which opened the posterior tibial artery, causing profuse hemorrhage. On the 23d of July the limb was amputated at the knee-joint by Dr. Draper, by a procedure similar in every respect to that employed in the preceding case. The patient died of exhaustion on the twenty-first day after the operation.

CASE 43.—W. W., æt. 22, Co. D, 52d N. C. Inf., C. S. A. Admitted into Chester Hospital July 14, 1863. This man, on the 3d of July, 1863, had received a gunshot fracture of the left tibia, the ball perforating the bone from before backward. He had also received a gunshot fracture of the metatarsal bones of the left foot. Sloughing ensued, with great burrowing of pus in the calf of the leg. On August 4, 1863, Dr. Draper amputated the leg at the knee-joint by the process employed in the two preceding cases. The patient made a good recovery, with a sound and useful stump.

CASE 44.—At the battle of Fredericksburg, Dec. 13, 1862, Assist. Surg. C. C. Lee, U. S. A., amputated at the knee-joint the limb of a soldier who had received a gunshot wound in the upper part of the leg a few hours previously. The flaps were integumental, and were taken from the front and back of the joint. The condyles and patella were left. The patient recovered.

CASE 45.—The same surgeon, at the Douglas Hospital in Washington, disarticulated at the knee-joint the leg of a soldier about 35 years of age, who, some days previously, had received a gunshot fracture of the head of the tibia, the fracture extending into the joint. The patella was left, and the tips of the condyles were sawn off. This patient died about three days after the operation, from general exhaustion and with slight symptoms of pyæmia.

The following American cases of amputation at the knee-joint have already been reported. Only their outlines are therefore submitted, with the references.

CASE 46.—Dr. Nathan Smith, of Connecticut, in April, 1824, amputated at the knee-joint the leg of Miss R. D., of Brunswick, Me., for long-standing disease of the bones and soft parts of the leg. Operative process—Anterior skin flap, leaving patella; and posterior flap of gastrocnemius. The patient recovered.—*Am. Med. Review*, vol. ii. p. 370.

CASE 47.—M. Blaquiere, in 1833, amputated at the knee-joint the leg of a Mexican Indian, æt. 25, for gangrene produced by the application of hot bricks during the cold stage of Asiatic cholera. Velpeau's operation. Recovery.—Mott's Velpeau, 1856, p. 243, from *Journ. des Connaiss.*, Paris, Août, 1844, p. 60.

CASE 48.—Dr. Catley, of Delaware, reports the case of S. S., æt. 33, whose leg was amputated at the knee-joint, in 1835, by a practitioner (not named), for gangrene, the result of a tight bandage applied just above the knee for laceration of popliteal artery. Reamputation of thigh thirteen years afterwards. Recovery.—*Ohio Med. and Surg. Journal*, vol. i. p. 126.

CASE 49.—Dr. Markoe, in the *N. Y. Journal of Medicine* for January, 1856, states that in 1841 he examined at the New York Hospital an excellent stump of the knee-joint amputation.

CASE 50.—In 1841, Dr. Pancoast, at the Philadelphia Hospital, removed at the knee-joint the leg of R. M., æt. 35, for necrosis of entire shaft of tibia. Operation by three integumental flaps, the patella and condyles of femur being left. Recovery.—Pancoast's *Operative Surgery*, 1846, p. 169.

CASE 51.—Dr. Stephen Smith, in the *N. Y. Journal of Medicine* for November, 1852, p. 318, reports the case of a saddler whose leg had been disarticulated at the knee with a razor, for gunshot injury of the leg. This patient presented himself at the clinic of the College of Physicians and Surgeons.

CASE 52.—The same surgeon in the same article reports the case of a coloured man upon whom amputation at the knee-joint was practised by Dr. Sabine, some years prior to report, for gangrene of the leg, following ligation of the femoral artery. Recovery.

CASE 53.—In the *N. Y. Journal of Medicine* for January, 1856, Dr. Markoe reports the case of E. C., æt. 35. Amputation at knee-joint, by circular method, by Dr. J. Kearney Rodgers, Feb. 9, 1846, at the New York Hospital, for severe burns. The patella was not removed. Died March 7, 1846.

CASE 54.—In the same *Journal*, Dr. Markoe also reports the case of T. H., æt. 21, whose leg was amputated previously at the knee-joint, for a railroad accident, by Dr. J. K. Rodgers, of the New York Hospital, Oct. 19, 1849. Antero-posterior skin flaps. This patient died Oct. 22, 1849.

CASE 55.—In the same paper, Dr. Markoe alludes to the case of D. B., æt. 36, whose leg was amputated at the knee-joint, at the New York Hospital, Jan. 21, 1849. Cause, syphilitic disease of the bones of the leg, followed by gangrene. Death Jan. 29, 1849.

CASE 56.—On the 7th of April, 1852, Dr. Parker, of New York, amputated at the knee-joint the leg of J. McN., æt. 25, for paralysis and atrophy of right leg, following an attack of scarlet fever at four years of age. Anterior integumental and posterior muscular flaps. Secondary hemorrhage on fifth, sixth, eleventh, twelfth, thirteenth, and twentieth days. Ligation of femoral artery on thirteenth day, and reamputation in continuity of femur on twentieth day. Recovery.—*N. Y. Journal of Medicine*, Nov. 1852.

CASE 57.—On the 30th of April, 1852, Dr. Buck, at the New York Hospital, removed at the knee-joint the leg of J. McA., æt. 13, which had been crushed a few hours before by two bars of railroad iron which fell upon it. Anterior and posterior flaps, and ends of condyles sawn off. Recovered.—*N. Y. Journal of Medicine*, Nov. 1852, and Jan. 1856.

CASE 58.—M. R., æt. 50. Amputation at knee-joint, by Dr. Buck, at the New York Hospital, for railroad crush of leg, Feb. 18, 1852. Small anterior and large posterior flap; patella left. Recovered with a good stump.—*N. Y. Journ. of Medicine*, Nov. 1852, and Jan. 1856.

CASE 59.—Dr. I. Moses reported to the New York Pathological Society the case of J. S., æt. 26, a Mexican, whose leg he amputated at the knee-joint, Nov. 22, 1854, for gunshot wound of leg, received five months previously. Short anterior skin flap, and long posterior muscular flap (Hoin's method). Condyles and patella left. Recovery with good stump.—*N. Y. Journ. of Med.*, Jan. 1856.

CASE 60.—A. M. H., aged two years and three months. Railroad crush of right leg, and laceration of soft parts of left leg. Right leg amputated by Dr. Markoe, May 18, 1855, five hours after injury. Long anterior and short posterior flaps, patella and condyles left. Recovery.—*N. Y. Journ. of Med.*, Jan. 1856.

CASE 61.—Dr. Halsted, on Aug. 7, 1855, at the N. Y. Hospital, amputated at the knee-joint the leg of A. B., æt. 34, for railroad compound fracture of right leg (also comminuted fracture of left arm). Long anterior and small posterior flap. Died on Aug. 11.—*N. Y. Journal of Medicine*, Jan. 1856. Had for some days previous suffered from delirium tremens. Died apparently worn out by constant convulsive movements.

CASE 62.—In the *N. Y. Journal of Med.*, Nov. 1856, Dr. Markoe reports the case of C. S., æt. 22, whose leg he amputated for chronic inflammation of the knee-joint, Nov. 3, 1855. Long anterior and short posterior flaps; patella removed, and surfaces of condyles sawn off. Recovered with a good sound stump.

CASE 63.—Dr. Markoe, at the N. Y. Hospital, on the 6th of Nov. 1855, removed, at the knee-joint, the leg of a brakesman on the Erie Railroad, æt. 22, which had been crushed between the driving wheel and side of an engine. Long anterior, and short posterior flaps. Patella and condyles left. The patient recovered.

CASE 64.—On Sept. 8, 1852, the leg of John K., æt. 39, which had been crushed by a log of mahogany, was amputated, at the N. Y. Hospital, at the knee-joint, by flaps. Condyles trimmed. This patient died forty-eight hours after the operation. The case was under the care of Dr. Watson.

In the *Richmond Medical Reporter*, vol. iii., No. 1, p. 55, will be found, in Dr. F. Sorel's statistics, a mention of eleven cases of knee-joint amputation, which were performed by southern surgeons. Five were primary, of which 3 died; and 6 were secondary, all of which died.

The following cases of amputations at the knee, and at the knee-joint, have been recorded in the British medical journals:—

CASE 65.—Mr. Syme reports, in the *Lond. and Ed. Monthly Journ. of Med.* for May, 1845, p. 337, the case of P. P., æt. 21, who suffered from abscess of the knee-joint. On March 2, 1844, Mr. Syme amputated the leg at the knee, making a long posterior flap from the calf, removing the patella, and sawing off the condyles. The patient recovered, and was discharged well on the 31st of May.

CASE 66.—In the same paper Mr. Syme reports the case of Jane M., æt. 22, whose leg he also successfully amputated at the knee for disease of the joint. The operation was similar to the previously described case, except that the anterior skin flap was made on the lower, instead of the upper margin of the patella.—*Am. Journ. of Med. Sci.*, July, 1845, p. 210.

CASES 67, 68.—In the *Lancet* for July 19, 1845, p. 79, and in the *Med. Times and Gaz.*, July 8, 1854, Sir Wm. Fergusson reports two cases of knee amputation for disease of the knee-joint. One of the patients was a man of 24 years of age; the other a boy aged 11. Both patients recovered with excellent stumps. The operation performed by this surgeon was by cutting a short anterior skin-flap, and a long posterior flap from the belly of the gastrocnemius, then sawing off the condyles, and removing the patella.—See *Am. Journ. of Med. Sci.*, Oct. 1854, p. 542.

CASE 69.—Dr. George W. Williamson, Assist. Surg. to the Forces, reports the case of Wm. L., æt. 18, whose leg he removed at the knee-joint for abscess, by Fergusson's process, on Dec. 31, 1845. The stump did not heal, the margin of the femur necrosed, and was sawn off, and the patient died April 3, 1846.

CASE 70.—In the *British Med. Journ.*, April 16, 1864, Mr. Carden reports one case, that of Wm. J., æt. 24, whose leg he disarticulated at the knee, Aug. 19, 1847, for abscess of the knee following fracture of the patella. From the account of this case, the condyles of the femur appear to have been left.

CASE 71.—One case of true amputation at the knee-joint, performed at the Glasgow Infirmary, with a fatal result, is recorded by Mr. Samuel Fenwick, in his Statistics of Operations Performed at Newcastle-upon-Tyne Infirmary, published in the *Monthly Journ. of Med. Sci.*, Oct. 1847, p. 248.

CASE 72.—G. M. Jones, Esq., Surgeon to the Jersey Hospital, records, in the *Med. Times and Gaz.*, the case of John S., æt. 35, whose leg he amputated at the knee-joint, for compound fracture of both bones, Nov. 10, 1853. This man recovered with a perfect stump. The operation consisted in a short anterior, and short posterior flap, the removal of the patella, and the articular end of the femur.

CASE 73.—In the *Lancet*, May 27, 1854, Mr. H. G. Potter, of Newcastle, reports the case of Harriet S., æt. 40, whose leg he removed at the knee-joint, by Fergusson's operation, Dec. 13, 1853, for abscess of the joint. The patient was discharged from hospital cured, March 17, 1854.

CASE 74.—Sir Wm. Fergusson reports, in the *Lancet* for Feb. 28, 1857, p. 215, having performed his amputation at the knee successfully on a young lad, Dec. 6, 1856, for necrosis of the tibia and abscess of the knee-joint.

CASES 75, 76, 77.—Mr. Lane, Surgeon to St. Mary's Hospital, London, in the *Lancet* for 1857, vol. ii. p. 324, and p. 474, reports the case of a boy 8 years of age, upon whom he performed disarticulation at the knee-joint on the 16th of Sept., for disease of the tibia involving the joint. The patient recovered. The operation practised by Mr. Lane consisted in the formation of a long anterior, and of a short posterior integumental flap. The patella and condyles were left undisturbed, and the incrusting cartilages were not touched. In the comments of the British medical press upon this case, it is stated that this operation of Mr. Lane's was the first one of the kind performed in England, although it had been previously performed at Glasgow, in the instance reported by Mr. Fenwick. In the *Lancet* for April 30, 1859, p. 440, Mr. Lane also reports two other cases of the same amputation, one was on the person of a man aged 38, and was performed April 6, 1859, for an epithelial cancer of the leg. The particulars of the other case are not stated. Both occurred at St. Mary's Hospital, in the service of Mr. Lane, and both recovered.

CASE 78.—Sir Wm. Fergusson, in the *Lancet* for April 24, 1858, narrates the case of George H., æt. 20, whose leg he amputated at the knee-joint for a tumour on the right tibia. The operation in this instance was by a long anterior, and short posterior skin flap. The condyles were left, but the patella was removed. The patient recovered.

CASE 79.—The same surgeon reports, in the *Lancet* for Dec. 10, 1859, an amputation at the knee-joint, on a man æt. 48, for medullary cancer of the fibula. The operation was done by anterior and posterior skin flaps. The condyles were left, and the patella was removed. The patient did well at first, but the wound subsequently fell into a sloughy condition, and the man died.

CASE 80.—Mr. Holthouse, at the Westminster Hospital, on Dec. 24, 1858, disarticulated at the knee the leg of H. H., a drayman, æt. 60, for a compound comminuted fracture of the bones of the leg, received ten days previously. Long anterior and short posterior flaps. Patella and condyles left. The patient had suffered from constant oozing of blood from the time of the accident up to date of operation, at which time he was in poor condition. He died from exhaustion.—*Lancet*, April 16, 1859.

CASE 81.—In the *Lancet* for Dec. 10, 1859, is reported a case of Mr. Coulson's, at St. Mary's Hospital, in which amputation was performed at the knee-joint, by Lane's method, for an encephaloid tumour of the right leg, chiefly attached to the tibia. The patient, S. E., a single woman, aged 18, recovered in forty-four days after the operation. Twelve months afterwards she had a good sound stump.

CASE 82.—Mr. Butcher, in his *Conservative Surgery*, p. 457, reports the case of Thomas K., æt. 45, whose leg, Feb. 25, 1860, he amputated at the knee for fracture following disease of the bone. The operation was performed by an anterior integumental and by a posterior long muscular flap. The condyles were sawn with Butcher's saw. The patient recovered with a satisfactory stump.

CASE 83.—In the *British Med. Journ.* for June 15, 1861, Mr. Dolman reports the case of John M., æt. 26, both of whose legs were crushed by a railroad accident. On April 11, 1860, a few hours after the accident, Mr. Fearn amputated the left leg just below the knee. The patient was allowed to recover from the shock, and the right leg was then amputated at the knee-joint by antero-posterior skin flaps. The patella and condyles were left, four ligatures were applied. On April 20 the left femoral artery was tied for secondary hemorrhage. The patient recovered, and, the report states, went up to London for artificial limbs.

CASE 84.—On November 17, 1864, Mr. Pollock amputated at the knee-joint the leg of James H., a wood-sawyer, æt. 51, for ulcer of the leg. Long anterior and short posterior flaps. The condyles and patella were left. This patient recovered with a good stump.—*British Med. Journ.*, 1865, p. 266, and *Lancet*, Jan. 13, 1866.

CASE 85.—In the last-named journal, the case of M. G., a female, æt. 55, half idiotic, is reported as having been operated upon by Mr. Pollock in a similar manner, Aug. 3, 1865, for an extensive ulcer of the left foot and lower half of left leg. She died Aug. 6. The report states that "when admitted into hospital she was in a very low state, and was evidently sinking from exhaustion."

CASE 86.—In the same journal is reported the case of J. S., æt. 12, whose leg was amputated at the knee-joint by Mr. T. Holmes, at St. George's Hospital, Sept. 14, 1865, for abscess of knee-joint. Operation by short anterior and long posterior flap, from muscles of calf. Patella removed, condyles left. Recovered.

CASES 87, 88.—In the *Edinburgh Med. Journ.* for April, 1866, p. 871, Mr. Syme reports the case of W. M., æt. 32, whose leg he amputated at the knee, by Carden's method, for compound fracture of the leg occurring on the railroad January 1. This patient recovered. Mr. Syme also reports a secondary amputation at the knee, by Carden's method, performed upon a boy æt. 6, whose foot he had previously amputated at the ankle, for a railroad injury. The child recovered.

CASE 89.—In the same journal Mr. Syme mentions a secondary amputation at the knee, by Carden's method, performed by Dr. Joseph Bell, Jan. 26, 1866, upon a man, both of whose legs had been fractured on the railroad. One leg was amputated at the knee, and the other was saved. This patient recovered.

CASES 90, 91.—On the 19th of Sept., 1865, Mr. Annandale amputated, at the knee, by Carden's process, both legs of a man, æt. 63, who had been injured by the fall of iron bars a few hours before. The patient recovered, a result unlooked for by the operator.

On Oct. 25, the same surgeon removed successfully, by the same method, the leg of a man for knee-joint disease.

CASE 92.—In the paper already quoted, Mr. Syme records the cases operated upon, secondarily, according to the same method, by Mr. Mackenzie, of Kelso, Oct. 23, 1865. The patient, a young farmer, who had received a compound fracture of the leg from a cart-shaft, made a good recovery with an excellent stump.

CASE 93.—On Feb. 4, 1865, Mr. Hislop, of N. Berwick, removed successfully, by the same process, for disease of the joint, the leg of a clergyman, who recovered with a comfortable stump.

CASE 94.—On Oct. 10, 1865, Mr. Cooper Foster, of Guy's Hospital, amputated, by the circular method at the knee-joint, the leg of a railway laborer, which had been lacerated by a hook attached to a capstan rope. The patella was removed, and the condyles were left. This patient recovered, and was discharged Nov. 18, 1865.—*Lancet*, Jan. 13, 1866.

In the course of his paper Mr. Syme also refers to five cases successfully operated upon, in a similar manner, by Prof. Lister, of Glasgow.

In concluding this summary of the reports of those British cases of knee and knee-joint amputations, which we have collected, it may be well also to append the statistics which have been furnished by Mr. Carden, in the paper already quoted, in the *British Medical Journal*, April 16, 1864. From 1846 to 1864, Mr. Carden performed 30 such amputations, with the following results :—

			Deaths.	Recoveries.
Accidents	Primary	4	1	3
“	Secondary	3	..	3
Advanced cancer . . .	“	6	3	3
Sloughing gangrene . . .	“	1	1	..
Disease	“	16	..	16
		30	5	25

We have subtracted from Mr. Carden's table the amputation at the joint proper, numbered 70 in the foregoing list.

In the following cases, occurring in France, Germany, and Russia, the details are sufficiently accurate for the purposes of our examination :—

CASE 95.—Recorded by Velpeau. On January 14, 1830, M. Velpeau disarticulated at the knee-joint the leg of a boy æt. 19, for necrosis of the tibia. The flap was formed from the integuments in front of the knee. The boy recovered, and wore a peg leg on which he could bear the weight of his body.

CASE 96.—A man, 29 years of age, received a compound fracture of the leg, which was followed by gangrene. On the 4th of June, 1830, M. Velpeau amputated the leg at the knee-joint by a circular operation. This man recovered with a good stump.

CASE 97.—In 1830 M. Velpeau examined the leg of a young man, aged 19, whose leg had been amputated seven years previously at the Hôpital des Enfans. He could walk perfectly well with an artificial limb.

CASE 98.—Baudens reports the case of a soldier wounded at Tafna, Jan. 26, 1836, whose leg he amputated by an anterior integumentary and posterior muscular flap. Portions of both condyles were removed. The wound healed well, making a satisfactory stump.

CASE 99.—The same surgeon also furnishes an account of an operation he performed on a young soldier, wounded April 1, 1836. The limb was removed by the circular method, and the stump proved to be a good one, admitting of the use of a wooden leg.

CASE 100.—M. Murville, of Lille, reports in the *Gazette Med. de Paris* for Nov. 31, 1845, the case of an infant 20 months of age, upon whom he performed amputation at the knee-joint for gangrene following a crush from a carriage-wheel. The case did well, and the stump proved to be an excellent one.

CASE 101.—The same surgeon also describes an operation performed by him upon a man aged 48, whose leg had become gangrenous from excessive inflammation following an injury to the ankle produced by a block of wood. The operation practised was by a short anterior, and long posterior muscular flap. The patella and condyles were left. At the end of sixty-two days the wound had cicatrized perfectly, and he afterwards used a wooden leg with great facility.

CASE 102.—In *Langenbeck's Archiv* for 1865, 7 Band, Zweiter heft, p. 489, is recorded the case of O. B., æt. 25, a Turk, who received a gunshot fracture of both bones of the leg, in July, 1854. The man underwent a long and exposed wagon-transportation, and the leg fell into bad condition. On January 30, 1855, Dr. J. Mazanowski disarticulated the limb at the knee-joint by Bauden's oval flap. Repeated attacks of secondary hemorrhage supervened, but the patient eventually recovered with an excellent useful stump.

CASE 103.—Operation by M. Maisonneuve. On March 1, 1854, this surgeon, at the Hôpital Cochin, disarticulated at the knee the leg of Augustine Ninot, æt. 22, for osteo-sarcoma of the leg. Twelve days afterwards the femoral artery was tied for secondary hemorrhage. The woman recovered, and was able to walk with agility on an artificial limb.—*Gaz. Méd. de Paris*, Sept. 2, 1854.

CASE 104.—Operation by Arlaud. (*Roux, De l'Ostéomyélite et des Amputations Secondaires, &c.*, p. 99. Paris, 1860.) S. D., a French soldier, æt. 23, was wounded at Solferino by a bullet, which fractured both bones of the leg. He was treated conservatively in Italy. Osseous union occurred, with excessive deposit of callus. On November 5, 1859, he was admitted into the Hospital of St. Mandrier. The leg presented fistulous openings, from which frequent exfoliations were removed. The patient was emaciated from excessive pain and continued suffering. As it was evident that the bone was affected, with extensive osteo-myelitis, the limb was amputated at the knee-joint by Bauden's oval operation December 19. On January 5 a large abscess formed in the thigh, which was opened. He then recovered rapidly, and was discharged from hospital February 25, perfectly cured, and furnished with a wooden leg, which permitted him to walk with facility.

CASES 105 to 114.—In the published statistics of the Surgical Clinic at Tubingen, from 1843 to 1863, p. 30, Stuttgart, 1863, Dr. Hermann Schmidt reports ten cases of amputation at the knee-joint. Of these, six recovered, and four died. Two of the deaths were from pyæmia. In both of these cases the condyles were removed. One death resulted from hemorrhage, and one from exhaustion. In two instances, the patella was excised. The indications for the amputation were, in four cases, caries or necrosis of the tibia; in four cases, ulcer of the leg; and in two cases, gangrene. The operation by the single anterior flap was performed seven times; the circular operation once; and the posterior muscular flap method once. The stumps of the cases which recovered seem to have been satisfactory. The reporter, however, prefers amputation in the continuity of the thigh to that of the knee, since the Tubingen statistics of the former operation present a less degree of mortality than the latter, which was forty per cent.

CASES 115 to 120.—In *Canstatt's Archiv* for 1857, p. 218, Dr. J. T. Heyfelder briefly refers to six cases in which he had performed amputation at the knee-joint. Two cases of this operation for compound fracture of the bones of the leg, died respectively about the tenth and twenty-fifth day, from pyæmia. Two other cases operated upon for caries of the leg bones also died from the same cause. One patient upon whom he had performed Hoin's posterior muscular flap operation died on the fourth day from pyæmia, probably caused, as the operator observes, by excessive suppuration from so large a muscular flap.

One other case, injured by an explosion, and operated upon by Bauden's method, recovered with a good stump, and at the end of five months was able to perform field work.

List of Cases of Disarticulation at the Knee, not included in the Tabulations of this Article.

	Recoveries.	Deaths.
De la Roque, 1773	1	
J. L. Petit, 1773	2	
Hoin, in Lyons, 1764	1	
Gignoux, of Valence (spontaneous	1	
Sabatier (spontaneous)	1	
Richerand	1	
Deziemeris	1	
Bourgeois, at Etampes	1	
Rossi	2	
Nivert	1	
Laugier	...	2
Velpeau[1]	...	4
Baudens[2]	1	2
Pichozel[2]	1	
Jobert[2]	...	1
Thos. Volpi[2]	2	1
Scrive, in Africa[2]	...	1
Gerdy[2]	...	1
Guyon[2]	...	1
Dupuytren[3]	...	3
Monteggia[3]	...	1
Wrabiez, in Vienna[4]	1	
Kern	2	3
Langenbeck	1	1
Textor, the elder	4	2
Beclard, 1823	1	
Ph. von Walther	...	1
Robert	1	
Bruns, in Tubingen	2	1
Munster, in Copenhagen	1	
Schuh, in Vienna	...	1
Textor, the younger	1	
Zeis, in Marburg, 1830	1	
Gunther, in Leipzig	...	1
J. L. Petit, 1774	1	
Larrey, in the year 3	1	
Coste, of Marseilles[5]	1	1
J. Heyfelder[6]	1	5
Vanzetti[6]	1	
Uhde[7]	3	2
Salleron, at Dohme-Bagatché, Constantinople for gunshot injuries[7]	1	11
Maupin, secondary amputations for gunshot injuries[7]	...	5
Total	40	33

In endeavouring to arrive at a correct estimate of the value of amputation at the knee-joint, it is well to regard the operation from a twofold point of view—*first*, as to the fatality of the operation especially as compared with amputation of the thigh ; *second*, as to the character and utility of the resulting stump.

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[1] For the cases referred to under the first twelve names, see Velpeau, Op. Surg., N. Y., 1856, p. 239.

[2] Ollagnier, Gaz. Méd. de Paris, 1849, p. 84 et seq.

[3] N. Y. Journ. of Med., Nov. 1852, p. 324.

[4] For this and the cases referred to under the succeeding fourteen names, see Günther, Blütige Operatione, Leipzig, 1855, facic. 13, p. 109.

[5] Canstatt, Jahresbericht, 1857, p. 219.

[6] Langenbeck's Archiv, 1865, Bd. 7, Heft. 2, p. 493.

[7] Uhde, die abnahme des vorderarms, Braunschweig, 1865, p. 134.

First. As to the fatality of amputation at the knee-joint. In determining this question we must refer to the statistics of the published cases. Unfortunately, it happens, that the number of reported operations is but limited, and if we except the papers of Velpeau, Stephen Smith, Markoe, Zeis, Ollagnier, Mazanowski, and a few others, we find little except the mention of an occasional operation. Indeed, a careful analysis of some of the most frequently quoted tables of knee-joint amputation leads to the conclusion, that many of the reported cases rest upon mere hearsay evidence, and are more than apocryphal. There is such evident duplication of cases, and absence of details, as to forbid the use of these tables as a basis for correct surgical deductions.

In collecting the cases cited in the preceding pages, the writer has admitted only such as bore the stamp of authenticity. All doubtful ones, and those wanting in description, have been excluded from the tabulations, but for the sake of reference they are appended in a supplementary list.

The tables, upon which the deductions of this paper are based, comprehend, it will be seen, the writer's own cases; other unreported American cases, obtained from manuscript sources; the published cases collected by Drs. Smith and Markoe; and well-authenticated published European operations. For purposes of comparison, the results of American and foreign practice are arrayed in separate summaries.

Summary of the Results of American Cases of Amputation at the Knee-joint.

		Cause.	Cases.	Recoveries.	Deaths.
Primary	Condyles left ; patella left . . .	Accident	15	11	4
Secondary	" " " " . . .	"	15	9	6
"	" " " " . . .	Disease	12	10	2
"	" " " removed . .	"	1	1	
Primary	Articular surfaces of condyles shaven off ; patella left	Accident	2	1	1
Secondary	Articular surfaces of condyles shaven off ; patella left	"	2	2	
Primary	Condyles sawn off ; patella left . .	"	7	4	3
Secondary	" " " " . .	"	3	2	1
"	" " " " . .	Disease	3	3	
"	" " " removed .	"	2	1	1
	Cause and period of operation undetermined		2	2	
	Total number of cases . .		64	46	18

	Cases.	Recoveries.	Deaths.	Per cent. of mortality.
Primary amputations after accident	24	16	8	33.33
Secondary amputations after accident	20	13	7	35.
Secondary amputations for disease	18	15	3	16.66
Cause and period of amputation undetermined	2	2		
Total	64	46	18	28

Summary of the Results of Foreign Cases of Amputation at the Knee-joint.[1]

		Cause.	Cases.	Recoveries.	Deaths.
Primary	Condyles left; patella left	Accident	7	4	3
“	“ “ “ removed	“	1	1	
Secondary	“ “ “ left	“	5	4	1
“	“ “ “ “	Disease	13	10	3
“	“ “ “ removed	“	8	5	3
Primary	Articular surfaces of condyles shaven off; patella left	Accident	1	1	
Secondary	Articular surfaces of condyles shaven off; patella left	“	1	1	
“	Articular surfaces of condyles shaven off; patella left	Disease	1	1	
“	Articular surfaces of condyles shaven off; patella removed	“	1	1	
“	Condyles sawn off; patella left	“	3	1	2
“	“ “ “ “ removed	“	6	5	1
	Total cases		47	34	13

	Cases.	Recoveries.	Deaths.	Per cent. of mortality.
Primary amputations after accident	9	6	3	33.33
Secondary amputations after accident	6	5	1	16.66
Secondary amputations for disease	32	23	9	28.75
Total	47	34	13	27.65

Table showing the Aggregate Results of American and Foreign Amputations at the Knee-joint.

	Cases.	Recoveries.	Deaths.	Per cent. of mortality.
Primary amputations after accident	33	22	11	33.33
Secondary amputations after accident	26	18	8	30.77
Secondary amputations after disease	50	38	12	24.
Cause and period of amputation undetermined	2	2		
Total number of cases	111	80	31	27.92

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[1] All amputations performed according to Mr. Carden's method have been excluded from this table.

Table showing the Mortality attendant upon the Retention or Removal of the Condyles of the Femur in Amputation at the Knee-joint.

Condyles left.	Cases.	Recoveries.	Deaths.	Per cent. of mortality.
American cases	45	33	12	26.66
Foreign cases	34	24	10	29.40
	79	57	22	27.84

Condyles removed.	Cases.	Recoveries.	Deaths.	Per cent. of mortality.
American cases	19	13	6	31.57
Foreign cases	13	10	3	23.
	32	23	9	28.12

The tables of the American operations embrace, it will be seen, 64 cases; of these 18 died, a mortality of 28 per cent. In 45 cases the condyles of the femur were not removed; of these 12 died, a death rate of 26.66. In 19 cases the condyles were sawn off to a greater or less extent; the mortality then being 31.57 per cent. In contrast with these figures the results of European practice would appear to be, a general death rate in 47 cases, of 27.65; for 34 cases in which the condyles were left, a mortality of 29.40; and in 13 cases in which they were removed, 23 per cent.

The rate of mortality for the aggregate American and European cases, 111 in number, is a little less than 28 per cent.; for 79 cases in which the condyles were left, 27.84; and in 32 cases in which they were removed, 28.12 per cent.

The mortality attendant upon 33 primary knee amputations after accident is 33.33 per cent.; upon 26 secondary amputations after accident, 30.77 per cent.; and upon 50 amputations for disease, 24 per cent.

From these data, it would seem that the mortality of amputation at the knee-joint is about 28 per cent. Pure disarticulation, in which the condyles and patella are left undisturbed, appears to be rather more favourable than disarticulation accompanied by ablation of these parts.

From the most recent statistics of the Surgeon General's Office, presented on a preceding page, the general average mortality of all cases of amputation at the knee-joint occurring in military practice during the rebellion, and reported to the Bureau, was about 50 per cent.

If we compare the mortality rate of amputation at the knee-joint with that attendant upon thigh amputation, the difference in favour of the former is most striking. By Mr. Syme the latter is set down at from 50 to 70 per cent. The statistics of M. Malgaigne, for the same operation in the Paris hospitals from 1836 to 1841, showed a mortality of 62.6 per cent.

Trelat's statistics, for the same hospitals from 1850 to 1861, give a death rate of 52.7 per cent. Dr. Gross, in his *Treatise on Surgery*, gives a mortality rate of 41.4 for 164 amputations in continuity of the thigh performed in American hospitals. For 194 amputations of the leg the same author states the death rate to be 35 per cent.

In view of the mortality incident to amputations of the leg and thigh, the question naturally arises, why is it that amputation through the knee, an intermediate point, is attended with comparatively less risk? This probably is owing:—

1. To the diminished shock of operation, which has always appeared to be a marked feature of this amputation. There is scarcely any operation of corresponding gravity, and certainly no major amputation, which is accompanied by so little—whether this be owing to the circumstance, that in this disarticulation as now generally practised by skin flaps, there is so little section of muscular tissue; or to the fact that the shaft of the thigh bone is not sawn across, or to both, is not clear. But it is undoubtedly true, that the shock in this amputation is disproportionately less than that of any other in its vicinity. In the writer's practice, this has more than once been regarded as a strong indication for the performance of the disarticulation.

2. To the nature of the tissues involved. If the disarticulation of the knee be practised by the circular process of Velpeau, the oval one of Baudens, or by the formation of antero-posterior or of lateral skin flaps, excessive incision and exposure of the muscular tissues is avoided. The suppurating surface is thus reduced to a minimum amount, and the chances of death from exhaustion are thus proportionately decreased.

3. To the fact, that in the disarticulation at the joint, and in the amputation through the cancellated structure of the femur, the shaft of the femur is not sawn across. Perhaps one of the most frequent causes of death after amputation in continuity in the lower extremity is pyæmic poisoning, so often the result of osteo-myelitis. The experience of our army surgeons in the late rebellion has, we think, shown this conclusively. The writer's observation in military practice has impressed him with the conviction that in all amputations in continuity, the patient's immunity from inflammation and disintegration of the medullary structures of the bones, is greatly influenced by the point at which the saw is applied. The nearer to the centre of the bone this is done the greater, probably, will be the chances of osteo-myelitis, and its disastrous sequelæ. A section of the bone through the cancellated structure or section through the epiphysis may, therefore, be regarded as less threatening to the life of a patient, all other circumstances being equal. This view appears all the more probable when it is remembered that the medullary canal exists only in the shaft of the bone, at the centre of which its diameter is greatest, and that it disappears as it approaches the epiphysis.

Dr. Markoe has already pointed out the liability of the femur to the formation of long tubular sequestra when its medullary canal has been opened, a remark which reference to the shelves of our different museums, and especially to that of the Army Medical Museum, will abundantly corroborate.

Danger of Amputation at the Knee-Joint.—Apart from the shock of operation, and the risks attendant upon all amputations, one or two points deserve especial notice in connection with knee amputations. The first of these is the occurrence of synovial inflammation, an event which seems to have been, and which still is feared by some. But, in reality, this is but an imaginary peril, for, as Dr. Stephen Smith has justly observed, "dangerous consequences from this source are rare exceptions in the severer wound of bisection of this articulation in amputation."

In none of the cases, which came under the writer's observation, have any unpleasant consequences been developed which could be charged to this cause. Indeed, it is not easy to see how they can occur, when it is remembered that the articulation is destroyed by the very performance of the operation, and also that in the course of a few days all traces of the synovial membrane disappear.

There is, however, one condition often encountered after knee amputations which does not seem to have met with the attention its gravity demands, save at the pens of some of the German writers. We refer to inflammation of the tendinous sheaths of the biceps, sartorius, semimembranosus, semitendinosus, and gracilis muscles. The invasion of this inflammation usually takes place from the second to the fifth day after the operation, and is attended by great swelling, tenderness on pressure, and pain in the stump, with considerable constitutional irritation. The stump assumes a bulbous appearance, and the progress of the inflammation is rapid and tends to suppuration. In those cases which the writer has observed, the biceps tendon was most often and earliest attacked. Occasionally the bursa over the patella became involved. The only treatment consists in early and free evacuations of these abscesses, otherwise extensive burrowing may occur, and the patient sink from pyæmia and exhaustion.

The *healing process* after amputation at the knee-joint may, under favourable circumstances, take place almost by first intention. This occurred in Case II., operated upon by the writer. When this happens the integuments covering the end of the femur are usually loose and movable, and the stump is best fitted to sustain pressure. Most frequently, however, only a partial direct union of the flap takes place, and here and there patches of slough separate from their edges. These sloughs leave the articular cartilage uncovered, and in several instances the writer has been enabled to study the process by which the cartilage loosens from the bone. Sometimes it softens, assumes a grayish appearance, and disappears, as it were, molecularly, gradually thinning; its particles being pushed off by the granulations from beneath, and washed away in the discharges.

About the eleventh or twelfth day after the operation, the vessels on the end of the bone beneath the softening cartilage become visible, and generally by about the twentieth day, the cartilage has entirely disappeared—at the same time the granulations from the bone spring up rapidly, and coalesce with those growing from the marginal surfaces, and from the crucial ligaments and soft tissues of the inter-condyloid notch. In other instances, on about the eighteenth or twentieth day, the softened articular cartilage separates in a thick layer from the subjacent bone, and can be readily removed in bulk with the forceps. The granulating process then takes place as already described. The growth of these granulations from the surface of the bone is usually so rapid that by the twenty-sixth or eighth day they reach the level of the surrounding soft tissues.

Operative process.—The main indication in the disarticulation of the knee is to obtain a sufficient amount of integumental covering to admit of the lips of the wound being brought together without strain. Whether this be accomplished by the circular or oval method, or by the formation of lateral, or of antero-posterior flaps, matters but little. The writer's experience inclines him to give the preference to the latter procedure. The anterior flap should, if possible, be cut long, so as to rest smoothly and loosely over the articular end of the femur. The cicatrix will then be out of the line of pressure on the application of an artificial limb.

The lateral flap method, first used by Rossi, has in the hands of some operators given satisfaction. It is well spoken of by Dr. D. P. Smith, late surgeon U. S. Vols., whose experience in regard to this operation has been considerable, and it has recently been employed by Dr. Stephen Smith in case 37, herewith reported. From his own observations the writer has thought, that in the lateral flap method the condyles are less liable to remain satisfactorily covered, and are more apt to project should any sloughing of the margins of the flaps occur, which probably happens to a greater or less extent in nearly all cases. Should sloughing take place after either of the other methods, the portion of bone uncovered is usually upon the posterior surface of the stump, a position of less importance than those exposed by the retraction or loss of any part of the lateral flaps.

One advantage the bilateral flaps unquestionably offer, and that is a dependent drainage for the wound. The importance of free drainage after disarticulation of the knee cannot be too strongly insisted upon, and no matter what operative process may be employed, it is clearly the surgeon's duty to see that a free vent is at all times afforded to the fluids collected under the coverings of the flap. Neglect of this precaution has to the writer's certain knowledge in more than one instance threatened a patient's life.

The formation of a posterior flap from the muscular tissues of the calf does not appear to have proved very successful in practice. It was abandoned by Mr. Syme, on account of the increased shock of the muscular section, the awkward fitting of the flap, the exhaustive suppuration, and the greatly increased risk of secondary hemorrhage.

The *Secondary Hemorrhage*, which follows amputation at the knee-joint is peculiar in its character, and deserves a careful consideration. It usually makes its appearance after reaction has been fairly brought about, and when the collateral circulation of the vessels of the stump is well established. The bleeding begins insidiously, and appearing at first to be passive in its character, does not excite apprehension. It is usually however obstinate, and there is a constant oozing from the wound. This it is difficult to arrest except by pressure over the main trunk, and when checked it is apt to recur at short intervals, on the removal of the pressure.

This hemorrhage which the writer on several occasions has had the opportunity of studying, takes place from the divided extremities of the articular vessels, especially of the azygos and inferior articular arteries, which are more particularly distributed to those internal structures divided in the section of the joint; these vessels, too small at the moment of operation to attract attention, subsequently enlarge and give rise to hemorrhage, which becomes serious from its continuance.

This circumstance appears to the writer of sufficient moment to be considered in the selection of the method of operation, which should be so conducted that the popliteal artery may be divided squarely across on the line of the articulation, and above the point at which the middle and lower articular arteries are given off. Such a result cannot of course be obtained in the performance of the amputation by the posterior muscular flap, for here the vitality of the large portion of the gastrocnemial muscle included in the flap, must to a great degree depend upon the integrity of the sural arteries. But as it is probable that these latter cannot be preserved, except at the risk of secondary bleeding from the joint structures, supplied by the articular arteries at higher points of origin from the popliteal, an additional reason is offered for the rejection of this mode of operation.

Another source of hemorrhage is the popliteal vein, which, when divided, is apt to gape, and unless tied may bleed to a considerable extent. This patency of the vein may be due to the firmness of the tissues in which it is imbedded, its many branches, and perhaps, also, as pointed out by Mr. Carden, to the disturbing pulsation of the neighbouring popliteal artery. In performing this amputation the writer has been in the habit of ligating the vein, and in no instance has any ill effect been observed.

The second point to be considered, is the *value of the stump* obtained after amputation at the knee-joint. Upon this subject patients, surgeons, and surgical mechanicians are agreed. Their testimony is nearly unanimous as to the serviceability of the stump, and its fitness for the adaptation of an artificial limb. In all of the operations, which have come within the writer's observation, the result in this respect has been favourable. There is seldom any tenderness on pressure, the patient generally bears his weight freely upon the end of the stump and can use an artificial limb with ease and comfort. The degree of motion preserved by the stump is wonderfully great, especially the power of rotation. In all of these cases the advantage of preserving the tendinous insertion of the adductor magnus muscle is manifest, and its effect in increasing the firmness of the patient's gait in walking is very marked. After the lapse of a year or two, and often much sooner, the condyles of the femur undergo considerable changes. They become smaller, rounder, and smoother, and, in fact, the end of the thigh bone assumes the same characteristics it would have possessed had the articular surfaces and condyloid projections been sawn off.

The writer has been informed by Mr. Palmer, the manufacturer of artificial limbs, that from a mechanical point of view he considers a good knee stump to be better suited for the adjustment of an artificial limb, than a good thigh stump. He also states that even though a slight degree of tenderness exist upon the surface of the stump after disarticulation at the knee, the artificial limb can be so applied by means of lacings as to sustain the weight of the body without permitting any pressure to be received upon the sensitive end of the stump.

It will be observed that in the present article no attempt has been made to consider in detail the indications for the performance of amputation through the knee. In general terms it may be stated that the operation can be resorted to with propriety, in many of those cases of injury and disease, which have hitherto demanded amputation through the lower third of the thigh; *provided* the integuments of the knee are sufficiently healthy to furnish material for flaps and *provided* also that the condyles of the femur are not involved to too great an extent.

Thus, amputation at the knee-joint might be performed :—

1. In crushed and compound fractures of the bones of the leg, extending up to, or involving the knee-joint.
2. In gunshot fractures of the bones of the leg, in the vicinity of, or involving the knee-joint.
3. In gunshot wounds of the knee-joint.
4. In gangrene of the leg, the result of injury to the great vessels or nerves.
5. In chronic and irreparable disease of the bones, or for tumours of the leg.
6. In degeneration, and abscess of the knee-joint.

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